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(71)Applicant : **NEC CORP**

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(72)Inventor : **IKEHATA YOSHIKAZU**

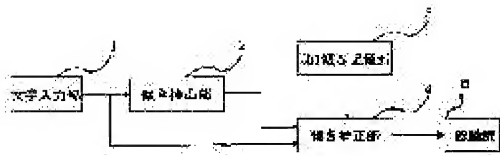
(54) ON-LINE CHARACTER RECOGNITION DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To eliminate the need for a special operation for inclination correction and to reduce burdens on a writer by correcting inclination by using the inclination of a pen on the input surface of a character obtained when the character is inputted.

SOLUTION: A character input part 1 inputs a character pattern written with the pen, an inclination detection part 2 detects the inclination (inclination angle) of the pen on the input surface of the character input part 1 and a first inclination storage part 3 holds a predetermined inclination angle. A inclination correction part 4 corrects the inclination of the character pattern by using the inclination angle detected in the inclination detection part 2 and the inclination angle held in the first inclination storage part 3 and then, a recognition part 5 recognizes the character pattern whose inclination is corrected. In this case, the

inclination detection part 2 obtains an angle formed by the projection of the pen to the input surface and a coordinate axis (x) as the inclination angle. The first inclination storage part 3 holds the inclination angle expected to be suited to many writers in the case of performing write so as not to obliquely incline the character beforehand.



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CLAIMS

[Claim(s)]

[Claim 1]An on-line character reader of a pen character input which has a character input part which inputs a character pattern written with a pen characterized by comprising the following.

A detected inclination part which detects an angle of inclination which shows a size of inclination of said pen.

An inclination correction part which amends inclination of said character pattern.

An inclination storage parts store holding an angle of inclination used as a standard of said inclination correction decided beforehand.

A recognition part which recognizes a character pattern by which inclination was amended by said inclination correction part.

[Claim 2]The on-line character reader according to claim 1 with which said inclination storage parts store is the 1st storage parts store stored in an angle of inclination defined beforehand, and said inclination correction part amends inclination of said character pattern using an angle of inclination detected in said detected inclination part, and an angle of inclination currently held at said 1st inclination storage parts store.

[Claim 3]The on-line character reader according to claim 1 which has the 2nd inclination storage parts store in which said inclination storage parts store holds an angle of inclination beforehand detected in said detected inclination part.

[Claim 4]Said storage parts store is the 3rd inclination storage parts store which classifies and holds a standard angle of inclination for every specific angle-of-inclination tendency, The on-line character reader according to claim 1 which has a selecting part which chooses a standard angle of inclination which corresponds from said 3rd inclination storage parts store with angle-of-inclination data which said detected inclination part outputted, and is shown to an inclination correction part.

[Claim 5]The on-line character reader according to claim 4 with which said 3rd inclination storage parts store is stored including an individual exception.

[Claim 6]The on-line character reader according to claim 1 which stores a standard angle which said 1st storage parts store defined statistically.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the on-line character reader which inputs a handwritten character on-line using a pen.

[0002]

[Description of the Prior Art] In order to perform highly precise recognition in the on-line character reader which recognizes by matching with the standard pattern conventionally remembered beforehand to be the inputted character pattern, it is desirable for the input direction of the character pattern by which human power was carried out to be the same direction as a standard pattern. However, when inputting a character into the electronic notebook etc. which carry especially a character recognition function when a character is inputted in handwriting, the character aslant leaning to the input frame or the equipment body may be written, and it has become a cause of recognition performance degradation.

[0003] In order to solve this problem, the method of recognizing by amending inclination of the character written aslant, etc. are used. The example is ** BE ***** to JP, 63-26926, A (the cited document 1 is called hereafter) and publication-number-33796 No. (the cited document 2 is called hereafter).

[0004] By the ** BE ***** method, before inputting a character into the cited document 1, the straight line 10 which shows the direction of the character to input as shown in drawing 6 is inputted into it, and the character 9 is inputted into it along the straight line. Then, it recognizes by amending inclination of the character 9 inputted using inclination of the straight line 10. As a means which shows the direction of the character to input, the rotary switch 11 as shown in drawing 7 in addition to straight-line 10 etc. are available. In the case of the rotary switch 11, the rotary switch 11 is rotated according to inclination of the inputted character, and it recognizes by amending inclination of a character using the angle of rotation.

[0005] By the ** BE ***** method, according to the direction of the character to input, two or more the input areas or pens of a character are prepared for the cited document 2, and inclination of a character is amended using the angle beforehand defined for every input area or pen to it. Or the angle for inclination correction is beforehand defined in a similar manner to information, including an inputted item, the beginning position of an input mode and character string entry column HE, etc., and inclination of a character is amended using it.

[0006]

[Problem(s) to be Solved by the Invention] The ** BE ***** method needs the operation of those other than character inputs, such as human power of the straight line

10 which shows the direction of the character to input, and setting out of the rotary switch 12, for the cited document 1, and the burden to a copyist is heavy.

[0007]Since inclination is amended [the ** BE ***** method] by the cited document 2 only at a fixed angle for every input area of a character, or pen, when a character is inputted into it except the angle, recognition performance deteriorates. It is also the same as when using other information, including a human power item etc.

[0008]The purpose of this invention has a small burden to a copyist, and there is in providing the on-line character reader which can amend inclination of a character with high precision.

[0009]

[Means for Solving the Problem]A means for solving mitigation of a burden of a copyist who is the 1st technical problem of this invention, A character input part which inputs a character pattern written with a pen, and a detected inclination part which detects an angle of inclination which shows a size of inclination of said pen, An inclination correction part which amends inclination of said character pattern using the 1st inclination storage parts store holding an angle of inclination used as a standard defined beforehand, and an angle of inclination detected in said detected inclination part and an angle of inclination currently held at said 1st inclination storage parts store, It has a recognition part which recognizes a character pattern by which inclination was amended by said inclination correction part.

[0010]A means for solving a limit of a range which is the 2nd technical problem of this invention and which can be amended has the 2nd inclination storage parts store holding an angle of inclination detected in said detected inclination part called for beforehand instead of said 1st inclination storage parts store.

[0011]Inclination of a pen on an input screen of a character and an input direction of a character have correlation, and if inclination of a pen changes, an input direction of a character will also change to the same extent. Then, the direction of inclination of a pen is detected and inclination of a character is amended using inclination of the pen.

Specifically inclination of a pen at the time of a character input is detected in a character human power part, a difference with a size of inclination of a pen at the time is usually searched for with the size, and inclination of a human power character is amended using the difference. Usually, a value defined beforehand and a value calculated by study for every copyist are used as inclination of a pen at the time.

[0012]

[Embodiment of the Invention]Next, a 1st embodiment of this invention is described with reference to drawings. Drawing 1 is a block diagram showing a 1st embodiment of this invention.

[0013]When drawing 1 is referred to, a 1st embodiment of this invention comprises the following:

The character input part 1 which carries out human power of the character pattern written with the pen.

The detected inclination part 2 which detects inclination (an angle of inclination is called hereafter) of the pen on the input screen of the character input part 1.

The 1st inclination storage parts store 3 holding the angle of inclination defined beforehand.

The inclination correction part 4 which amends inclination of a character pattern using

the angle of inclination detected in the detected inclination part 2, and the angle of inclination currently held at the 1st inclination storage parts store 3, and the recognition part 5 which recognizes the character pattern by which inclination was amended.

[0014]The detected inclination part 2 calculates angle θ_n which the projection 13 and the axis of coordinates x of the pen 12 of input screen HE make as an angle of inclination, as shown in drawing 3. The 1st inclination storage parts store 3 has held beforehand angle-of-inclination θ_0 expected to suit many copyists, when a character writes that it does not incline aslant.

[0015]Next, operation of a 1st embodiment of this invention is explained with reference to drawing 1 and drawing 2. Drawing 2 is a flow chart of operation of a 1st embodiment of this invention.

[0016]As opposed to the character L written using the locus of a pen after a pen touches an input screen with the character input part 1 until it separates 1 or more **, All the loci are sampled with a certain time interval, and the coordinate value (x_n, y_n) ($n=1, 2, \dots, N$, however N are the number of the sampling points to the character L, and call coordinate data below) of each sampling point is calculated. At this time, the angle information which a pen and an input screen when each sampling point is inputted make is searched for (Step S1). As angle information, WAKOMU command reference Fau WAKOMU you dee series digitizer (WAKOMU two S / WAKOMU Fau) (Wacomcomand reference for Wacom UD Series.)An angle (α_n, β_n) ($n=1, 2, \dots, N$) as shown in ** BE ***** and drawing 3 on Digitizer Vol(Wacom II-S/Wacom IV). December 20, 4-1995 is used. In drawing 3, a x-y flat surface is an input screen, and the angle at which the projection and the z-axis of a pen to an α_n and y-z flat-surface top make the angle which the projection and the z-axis of a pen of xz flat-surface top HE make is made into β_n .

[0017]The detected inclination part 2 calculates angle θ_n which the projection and the x axis of a pen to a human power side as shown in drawing 3 make from a formula (1) using the angle information (α_n, β_n) ($n=1, 2, \dots, N$) searched for by the character input part 1.

[0018]

[Equation 1]

$$\theta_n = \arctan\left(\frac{\tan\beta_n}{\tan\alpha_n}\right) \quad (1)$$

The average value over all the θ_n is calculated as the angle of inclination θ to the character L (Step S2).

[0019]

[Equation 2]

$$\theta = \left(\frac{1}{N}\right) \sum_{n=1}^N \theta_n \quad (2)$$

The inclination correction part 4 asks for correction angle ** $\theta = \theta_0$ [which the angle of inclination θ to the character L and the 1st inclination storage parts store 3 hold / from angle-of-inclination θ_0]- θ , It asks for character-pattern $P = \{(x'_n, y'_n) | n=1, 2, \dots, N\}$ which amended inclination to the character L from a formula (3) and a formula (4) using correction angle ** θ (Step S3).

[0020]

$$x' = x \cos \Delta \theta + y \sin \Delta \theta \quad (3)$$

$$y' = -x \sin \Delta \theta + y \cos \Delta \theta \quad (4)$$

The recognition part 5 receives character-pattern P, Proceeding OBU, the second International conference on document analysis and REKOGUNISHON (Proceeding of the second international.) conference on document analysis and recognition 1993 year 10 month 204-207 page. "A paper of a statement On-line Japanese character REKOGUNISHIYON IKUSU per face Bayh Anh off-line method based on normalization KOOPELETEITSUDO feature IKUSU traction. (ON-LINE JAPANESE CHARACTER RECOGNITION EXPERIMENTS BY AN OFF LINE METHOD BASED ON NORMALIZATION CO-OPERATED FEATURE) EXTRACTION -- ** BE ***** -- it recognizes using the method of superposition using the direction feature of a character [like] (step S4).

[0021] Next, an effect of a 1st embodiment of this invention is explained. Since a 1st embodiment of this invention amends inclination of a character using information acquired at the time of a character input, operations other than a literary input become unnecessary, and a burden to a copyist becomes small.

[0022] Next, the 2nd gestalt of this invention is explained with reference to drawings. Drawing 4 is a block diagram showing a 2nd embodiment of this invention.

[0023] a 1st embodiment a 2nd embodiment of this invention was indicated to be to drawing 1 when drawing 4 was referred to, and a ratio -- the connecting switch 6 which performs BE, and ON/OFF of connection, and the changeover switch 7 which performs a change of operation are added, and it differs in that it has the 2nd inclination storage parts store 8 instead of being the 1st inclination storage parts store 3.

[0024] The connecting switch 6 is OFF when learning an angle of inclination peculiar to a copyist, is set to ON at the time of recognition, and connects the character input part 1 and the inclination correction part 4.

[0025] The changeover switch 7 connects the detected inclination part 2 and the 2nd inclination storage parts store 8 at the time of study, and connects the detected inclination part 2 and the inclination correction part 4 at the time of recognition.

[0026] In 100 million copies of accounts of the 2nd inclination, 8 holds an angle of inclination peculiar to a copyist detected in the detected inclination part 2 at the time of study.

[0027] Since this angle of inclination is an amendment reference standard, it is also possible to consider it as an individual or to write and according to peculiarity group exception.

[0028] Next, operation of a 2nd embodiment of this invention is explained with reference to drawing 4 and drawing 5. Drawing 5 is a flow chart which shows operation of a 2nd embodiment of this invention.

[0029] First, in order to learn an angle of inclination peculiar to a copyist, the connecting switch 6 serves as OFF and the changeover switch 7 connects the detected inclination part 2 and the 2nd inclination storage parts store 8 (Step S11). Since operation of the character human power part 1 in a 2nd embodiment shown by step S12 of drawing 5 (a) and S13 and the detected inclination part 2 is the same as each part L of a 1st embodiment shown by drawing 1, and operation of 2, explanation is omitted. An angle of inclination to a character inputted by these operations for a copyist's study is called for. The 2nd inclination storage parts store 8 holds a called-for angle of inclination (Step

S14).

[0030]At the time of recognition, a connecting switch is first set to 0N, the character input part 1 and the inclination correction part 4 are connected, and the changeover switch 7 connects the detected inclination part 2 and the inclination correction part 4 (Step S21).

[0031]After that, it recognizes in the same operation as a 1st embodiment except a point using an angle of inclination held at the 2nd inclination storage parts store 8 instead of an angle of inclination currently held at the 1st inclination storage parts store 3 (Step S22, S23, S24, S25).

[0032]Next, an effect of a 2nd embodiment of this invention is explained. Since a reliable angle of inclination can be held and it can hold for every copyist further by writing a character that a 2nd embodiment of this invention serves as the direction as a standard pattern with same input direction of a character at the time of study, highly precise inclination correction can be performed.

[0033]

[Example]Next, operation of one example of a 1st embodiment of this invention is explained in detail.

[0034]The 1st inclination storage parts store 3 assumes that angle-of-inclination $\theta_0=60$ degree is held.

[0035]For example, the character "***" is inputted from the character input part 1, and as shown in drawing 8, suppose that it was sampled by 18 points. The coordinate data in this case ($n=1, 2, \dots, 18$) (x_n, y_n) is as follows.

{(0,4)(1,5)(2,6)(0,6)(1,5)(2,4)(3,3)(4,2)(3,5)(3,4)(3,3)(2,2)(1,3)(2,4)(4,5)(5,4)(5,3)(5,2)}
Angle information ($n=1, 2, \dots, 18$) (α^n) presupposes that it was as follows.
{. (60, 20).

(58,23)(61,25)(70,30)(68,40)(62,22)(63,32)(59,32)(80,40)(85,45)(72,30)(77,38)(76,43)(59,43)(66,38)(70,36)(78,41)(77,39)}

The detected inclination part 2 calculates θ_n ($n=1, 2, \dots, 18$) using a formula (1) from this angle information. θ_n is as follows.

{(11.9,14.9,14.5,11.9,18.7,12.1,17.7,,20.6,8.4,5.0,10.6,10.2,13.1,29.3,19.2,14.8,10.5,10.6)}

From these, it asks for the angle of inclination θ to an input character "***" using a formula (2). As a result, $\theta=14.1$ degrees is obtained.

[0036]The inclination correction part 4 calculates correction angle $\theta-\theta_0=60-14.1=45.9$, and amends inclination by the formula (3) and a formula (4) to an input character "***" using this correction angle from angle-of-inclination $\theta_0=60$ which the angle of inclination $\theta=14.1$ and the 1st inclination storage parts store 3 hold. As a result, the character pattern which comprises the following coordinate data as shown in drawing 9 is called for.

{. (2.9, 2.8). (4.3, 2.8). (5.7, 2.7). (4.3, 4.2). (4.3, 2.8). (4.3, 1.4)} [(5.6, -1.5) / (4.9, -2.2)] (4.2, -0.1) (4.2, -1.5) (5.7, 1.3) (5.0, 0.6) (4.2, -0.1) (2.8, 0.0) (2.9, 1.4) (4.3, 1.4) (6.4, 0.6) (6.4, 0.8)

The recognition part 5 recognizes to this character pattern.

[0037]Next, operation of the 1st example of a 2nd embodiment of this invention is explained in detail.

[0038]Since operation of a 2nd embodiment of this invention differs only in the operation

which holds an angle of inclination to operation of a 1st embodiment of this invention, and the 2nd inclination storage parts store 8 at the time of study, it explains only the operation at the time of study here.

[0039]For example, as human power of the character "***" written not to incline aslant is carried out and it is shown in drawing 10 from the character input part 1, it is sampled by 20 points and the angle information at this time ($n = 1, 2, \dots, 20$) (α_n, β_n) presupposes that it was as follows.

{. (50, 80). (55, 78). (45, 80).

(60,80)(62,78)(58,78)(58,70)(52,67)(55,64)(56,60)(48,60)(50,62)(53,72)(54,82)(63,82)(69,73)(54,68)(53,62)(48,64)(55,87)}

The detected inclination part 2 calculates θ_n ($n = 1, 2, \dots, 20$) using a formula (1) from this angle information, and asks for the angle of inclination θ using a formula (2) further. As a result, $\theta = 66.0$ degrees is obtained, and this θ is held to the 2nd inclination storage parts store 8.

[0040]According to 1st and 2nd embodiments, in the detected inclination part 2, although it asked for θ from the angle information (α_n, β_n) acquired from the character input part 1, a character human power part which carries out direct detection of the θ_n can also be used. Although θ_n considered it as the angle which the projection and the x axis of a pen of input screen HE make, it is also possible to use the axis used as foundations, such as the y-axes other than a x axis, and the angle to make. Although the average value of θ_n was used as the angle of inclination θ , it is also possible to use other central values, such as the maximum of θ_n .

[0041]In the inclination correction part 4, although inclination was amended using correction angle θ directly, what carried out the fixed multiple of θ is possible also for using the function which made θ the variable.

[0042]being related with the identification method of the recognition part 5 -- "the online recognition of the frame-less note character by the candidates-characters lattice method" of Institute of Electronics, Information and Communication Engineers paper magazine'85/4Vol.J68-DNo.4 -- θ BE ***** -- it needs. The method of calculating the optimal solution with combination variously can also realize the inputted stroke. It is not necessary to necessarily perform recognition. In one, the number of characters inputted in order to ask for the angle of inclination held to the 2nd inclination storage parts store 8 may not be restricted, but plurality may be sufficient as it.

[0043]Next, the 2nd example of a 2nd embodiment is described. As shown in drawing 11, it has the 3rd inclination storage parts store 18, and the standard angle of inclination of the amendment reference an individual exception and according to group is stored. Reception of the output of the detected inclination part 2 will have the selecting part 15 which chooses the angle of inclination of the individual and group applicable to this data, and is shown to reference of the inclination correction part 4.

[0044]

[Effect of the Invention]As explained above, since the on-line character reader of this invention performs inclination correction using inclination of the pen on the input screen of a character obtained at the time of a character input, its special operation for inclination assistant θ is unnecessary, and it can make the burden to a copyist small. It is effective in the ability to perform highly precise inclination correction by searching for information required for amendment by study beforehand for every copyist.